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Effect of surface oxidation on performance of $Ti_3C_2T_x$/MO composite as anode materials for lithium ion batteries

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Recently, a new group of 2D material showed a great promise in supercapacitors and batteries application due to their good conductivity as well as hydrophilic nature. It has general formula $M_{n+1}X_n$, where n=1, 2 or 3, M is an early transitional metal and X is C and/or N. According to X-ray photoelectron spectroscopy (XPS) and energy dispersive X-ray spectrometry (EDS) studies, MXenes can be terminated with a mixture of O, OH, and/or F groups depending on the chemical etching method and post-treatment. The as-synthesized MXenes are electronically conducting and hydrophilic which is a unique combination. Ultrasonication can be used to delaminate the 2D layers and produce single-layer and few-layered flake. As MXenes are hydrophilic, once delaminated, they form stable, surfactant-free colloidal solutions in water. The possibility of intercalating MXenes with various organic molecules plays a critical role for utilizing MXene in a range of applications, from polymer reinforcements to energy storage systems. The MXenes' 2D morphology, together with to their good electronic conductivities, render them strong candidates for many applications that range from sensors and electronic device materials to catalysts in the chemical industry, conductive reinforcement additives to polymers, and electrochemical energy storage materials, among many others. We have used hydrothermal route to synthesize nanocomposite material i.e. $Ti_3C_2T_x$/MO (MO= Fe_2O_3, Co_3O_4). After hydrothermal treatment, nanocomposite was calcinated at 400°C for 4 hours to get rid of entrapped moisture. Nano-composite was characterized using scanning electron microscopy, transmission electron microscopy and X-ray diffraction. After synthesis, nanocomposite was applied as anode in lithium ion battery. Anode was fabricated as thin film using doctor blade on copper foil. $Ti_3C_2T_x/Fe_2O_3$ composite as anode material exhibited discharge and charge capacities of 190 and 120mAh/g, respectively. Characterization shows that the MO nanoparticles are not uniformly distributed and also X-ray diffraction analysis has confirmed that $Ti_3C_2T_x$ has oxidized during hydrothermal treatment. Due to oxidation, the surface of $Ti_3C_2T_x$ was decomposed to TiO_2 and leaving carbon sheets behind which played a big role in decreasing conductivity of the anode. In turn, it has greatly affected its performance as anode material in the lithium ion batteries. To enhance its performance as anode material in Lithium ion batteries, it is extremely important to protect it from oxidizing. For this purpose, it should be exfoliated in a medium other than water. Besides this, metal oxide should be uniformly distributed.

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Study of slurry electrode properties for flow battery energy storage systems

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With the growing efforts to integrate electricity generated from renewable energy options to power grid, energy storage is envisioned to play an important role in enhancing grid utilization, reliability and robustness. Energy storage, especially for renewable energy has been a challenging task due to its high costs and large footprint. Redox flow battery (RFB) offers a robust opportunity for grid and off-grid application due to flexibility in scalable energy capacity, safety, non-region specific and long life cycle. In order to attain the enduring cost requirements and performance for grid energy storage, a system-level cost of about $150 per kWh is required. The relatively low energy density of the reactant fluids in the conventional RFB contributes to high system cost, which is presently in the range of $400 per kWh. To tackle this issue, an alternative approach based on flowable electrode (slurry electrode) is sought to increase the energy density and thus to reduce the system cost. Slurry electrode for electrochemical flow cells has attracted much attention as a potential technology that can improve the energy density and bring the system costs down. In this presentation, a study of flowable electrode based on carbon and redox systems (e.g., V/Carbon, Zn/C), focusing in particular on physical properties, such as conductivity, viscosity, electrode performance and cell performance will be presented and discussed.

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